Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; SP1: 168-170

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Screening of single cross hybrids and inbred lines of maize for Turcicum Leaf Blight (*Excerohilum turcicum*) under artificial epiphytotic conditions

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Abstract
Turcicum Leaf Blight (TLB) caused by *Exserohilum turcicum* is a major foliar disease of maize in Karnataka with yield losses upto 70% under severe cases. In the context of developing tolerant genotypes against this disease an experiment was conducted using 16 CIMMYT and IIMR germplasm lines selected based on their test weight and *per se* performance and were crossed with 3 testers (CM-111,CM-500 & PA-15) to produce 48 experimental hybrids in Line X Tester design. These hybrids along with the parents were sown in Kharif 2016 at Main Agricultural Research Station (MARS), UAS, Dharwad to study the disease reaction against TLB. Scoring was done using 1 to 5 scale (Payak & Sharma, 1983), where 1 being highly resistant and 5 being highly susceptible. The performance of these lines and hybrids were compared with the resistant check CI-4 and susceptible check CM-202. Artificial inoculation was done in the leaf whorls with grounded TLB infected leaves at 45 days after sowing and were scored at silk drying stage. Hybrids GH-1518, GH-1523 and lines P-4,P-5,P-6 were found to be highly resistant while the hybrids GH-1540, GH-1541and line P-8, P-15 showed highly susceptible reaction. This information can be useful for selection of parents and to develop tolerant hybrids in breeding programs or utilize them as source of resistance.

Keywords: TLB, Single Cross Hybrids, Artificial inoculation, Resistance, Tolerance

Introduction
Maize (Zea mays L.) is an important crop globally due to its high yield potential and serves as food, feed and provides raw materials for agro-allied industries in the world. In India, it is the third important cereal after wheat and rice in terms of area and production. The global average productivity of maize is 55.0 q/ha and India's productivity is 25.1 q/ha. In Karnataka, maize occupies an area of 1.17 mha, with the production of 3.26 mt and average productivity is 2.7 t/ha (Annual Progress Report, *Kharif* maize, 2014, AICRP on maize). Despite its high yield potential, one of the major limiting factors to maize grain yield is its sensitivity to several diseases. Approximately 65 pathogens infect maize. Turcicum Leaf Blight (TLB) caused by *Exserohilum turcicum* is one of the major foliar diseases in maize causing more than 50% yield loss in severe cases in Karnataka. Due to moderate low temperature and high humidity during the maize growing period, TLB has become a major disease.

TLB occurs sporadically in humid areas where maize is grown. TLB causes leaf necrosis and premature death of foliage which reduces the fodder and grain value of the crop. In India the diseases are prevalent in the states of Karnataka, Himachal Pradesh, Uttar Pradesh, Uttarakhand, Orissa, Andhra Pradesh and North Eastern Hill states. It also affects the Rabi maize in the plains of India. TLB is endemic in all maize growing areas and considered as a limiting biotic factor for successful cultivation of maize, which results in significant yield losses in the range of 28 to 91 per cent (Pant *et al*., 2000) [6]. TLB caused by *Exserohilum turcicum* (Pass.) Leonard and Suggs, is known to infect maize from the seedling stage to maturity. the symptoms first start as small elliptical spots on the leaves as grayish green with water soaked lesions parallel to leaf margins, the spots turn grayish with age and increase in size, finally attaining a spindle shape with long elliptical grayish or tan lesions. If the disease starts at an early stage, it causes premature death of the blighted leaves. As a result the crop loses their nutritive value as fodder (Payak and Renfro.1968) [7], have reduced germination capacity, vigor, GY and total sugar content (Ferguson and Carson, 2004) [8] have restricted Starch formation, chaffy kernels and infected plants are liable to infection with stalk rots (Henry and Kettelewell. 1996) [9]. The fungus has a wide host range and a high pathogenic variability with several races already reported in different parts of the world (The genetics of resistance is determined in most of maze genotypes quantitatively and has been used for

control of this disease. Resistance was reported to be partially dominant and controlled by many genes (Vanderplank, 1963) [10]

Although the losses due to these diseases can be minimized by foliar application of fungicides, the most appropriate and economical strategy is to use host plant resistance and resistance breeding programmes. In this context an experiment was designed to identify new hybrids and sources of resistance against Turcicum Leaf Blight for future use in maize breeding program.

Materials and Methods

In the context of screening tolerant genotypes against this disease an experiment was conducted using 16 CIMMYT and IIMR germplasm lines selected based on their disease reaction, test weight and per se performance. These lines were crossed with 3 testers (CM-111, CM-500 & PA-15) to produce 48 single cross hybrids in Line X Tester design. These hybrids along with the parents were sown in Kharif 2016 at Main Agricultural Research Station (MARS), UAS, Dharwad (Northern transition zone (Zone VIII) of Karnataka) to study the disease reaction against TLB. This location has been identifies as one of the hot spots for TLB incidence (Harlapur *et al.*, 2007) [11]. The performance of these lines and hybrids were compared with the resistant check CI-4 and susceptible check CM-202. Along with these three checks; GH-0727, NK-6240 and CP-818 were also evaluated as a comparison with the developed hybrids.

Inoculation of pathogen on host

Artificial inoculation was done by collecting heavily infected leaves collected from the previous season. These infected leaves were stored in large gunny bags in dry conditions protected from moisture and rodents. To prepare the inoculum, the dried leaves were grounded into a meal about the coarseness of wheat bran. Inoculation was done at 45 days of sowing (when plant attains the height of 30-45 cm) by placing a pinch of leaf meal into whorl of each plant. In order to counteract the prevailing dry weather, water was applied in the whorls by means of sprayer (high humid weather is congenial for the establishment and disease spread).

Evaluation and recording of disease reaction

The scale consists of five broad categories designated by numerals from 1 to 5 (Payak & Sharma, 1983). Scoring was done at silk drying stage of the plant. The classification has been given in Table.1.

Table 1: Scoring classification under 1 – 5 rating scale (Payak & Sharma, 1983).

SCORE	DESCRIPTION	CATEGORY/CLASSIFICATION
1.0	Very slight to slight infection, one or two to few scattered lesions on lower leaves.	Highly Resistant (HR)
2.0	Light infection, moderate number of lesions on lowerleaves only.	Resistant (R)
3.0	Moderate infection, abundant lesions are on lower leaves, few on middle leaves.	Moderately Resistant (MR)
4.0	Heavy infection, lesions are abundant on lower and middle leaves, extending to upper leaves.	Susceptible (S)
5.0	Very heavy infection, lesions abundant on almost all leaves, plants prematurely dry or killed by the disease.	Highly Susceptible (HS)

Result and discussion

Continuous efforts to locate the resistant source and utilization in resistant breeding programme are imperative to manage the disease in long run. Disease reaction indicated satisfactory level of disease development and thereby the classification into different classes was appropriate and easier. The screening trial has revealed that out of the 48 hybrids screened for TLB, only two showed highly resistant reaction, nine hybrids exhibited resistant reaction, 14 hybrids exhibited moderately resistant reaction, five hybrids exhibited susceptible reaction and two hybrids exhibited highly susceptible reaction. Out of the 16 lines, four were highly resistant, three were moderately resistant, two were susceptible and two were highly susceptible. Hybrids; GH-1518, GH-1523 and lines; P-4, P-5, P-6 were found to be highly resistant while the hybrids; GH-1540, GH-1541and lines; P-8, P-15 showed highly susceptible reaction for TLB (Table.2). Of the three checks NK-6240 showed moderate resistant, while GH-0727 and CP-818 were susceptible to the disease. These findings were in agreement with Harlapur (2005) [5] and Dharanendra (2003) [4]. The resistant check (CI-4) displayed a score of one (Highly resistant) and the susceptible check (CM-202) exhibited a score of four (susceptible) for both TLB (Fig.1). These lines and crosses identified hold excellent promise for resistance against *E. turcicum*. Hence, it can be used for developing hybrids and composites in future programme of breeding for disease resistance. However, reconfirmation of resistance is required. Further development of single cross hybrids coupled with TLB disease tolerance would certainly augment the productivity.

Table 2: Disease reaction of hybrids and inbred lines against TLB under artificial epiphytotic condition

Sl. No.	Genotypes	Parents/ Check	Scale	Disease reaction
1	GH-1523, GH-1518	P-4, P-5, P-6, CI-4	1	Highly Resistant (HR)
2	GH-1504, GH-1512, GH-1513, GH-1515, GH-1516, GH-1518, GH-1519, GH-1520, GH-1522, GH-1533, GH-1519, GH-1520, GH-1522	-	2	Resistant (R)
3	GH-1502, GH-1507, GH-1510, GH-1514, GH-1517, GH-1521, GH-1524, GH-1525, GH-1526, GH-1527, GH-1528, GH-1531, GH-1536, GH-1537, NK-6240	CM-111, PA-15, P-1, P-2, P-13	3	Moderately Resistant (MR)
4	GH-1501, GH-1503, GH-1506 GH-1505, GH-1508, GH-1509, GH-1511 GH-1529, GH-1530, GH-1532, GH-1534, GH-1535, GH-1538, GH-1539, GH-1542, GH-1543, GH-1544, GH-1545, GH-1546, GH-1547, GH-1548, GH-0727, CP-818	P-3, P-7, P-9, P-10, P-11, P-12, P-14, P-16, CM-202,	4	Susceptible (S)
5	GH-1540, GH-1541	P-8, P-15	5	Highly Susceptible (HS)

Fig 1: Resistant check CI-4 (left), Susceptible check CM-202 (right)

Fig 2: Foliar symptoms Turcicum leaf blight

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